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COOPERATIVE MARINE PILING INVESTIGATION: PHASE 1 - PILE DRIVING AT COCO SOLO, CANAL ZONE

TN-473

29 April 1963

U. S. Naval Civil Engineering
Laboratory
Port Hueneme, California

COOPERATIVE MARINE PILING INVESTIGATION: PHASE 1 - PILE DRIVING AT COCO SOLO, CANAL ZONE

Y-R005-07-007

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by

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ABSTRACT

The Cooperative Marine Piling Committee and the Bureau of Yards and Docks exposed 54 specially treated piles at Coco Solo Annex, Rodman Naval Station, Canal Zone. The treatments being evaluated are chromated copper arsenate followed by creosote, ammoniated copper arsenate followed by creosote, and phenylmercuric oleate in creosote-coal tar solution. Unmodified 70/30 creosote-coal tar solution is being used as the comparison standard.

This report describes the installation of these piles at the test site.

INTRODUCTION

The Cooperative Marine Piling Committee is composed of interested representatives of industry, a representative of the Forest Products Laboratory, and a representative from the W. F. Clapp Laboratories. The committee has been active in promoting research work, both by private industry and by government and private laboratories, to improve the performance of marine piling. On 1 September 1960 Dr. R. H. Bescher, Chairman of the Cooperative Marine Piling Committee, wrote to RADM E. J. Peltier, Chief, Bureau of Yards and Docks, requesting that the Bureau cooperate with the committee in providing exposure sites for specially treated experimental piles at Pearl Harbor and Guantanemo Bay, Cuba, or some other location in the Caribbean. Coco Solo, Canal Zone, was subsequently chosen by the Bureau as the Atlantic Ocean site.

During a telephone conversation between Mr. T. H. Moller, Code 74C, Bureau of Yards and Docks, and Dr. R. H. Bescher on 21 September 1960, it was agreed that the test program originally conceived by the committee would be expanded by the inclusion of piles treated with one and five percent phenylmercuric oleate in creosote. By letter of 23 September 1960 to Dr. R. H. Bescher, the Bureau confirmed the above conversation and the support for the proposed tests.

The original program was designed to compare three treatment systems. These are: 70/30 creosote-coal tar solution, chromated copper arsenate followed by creosote, and ammoniacal copper arsenate followed by creosote. The first two treatments were impregnated into both Southern Yellow Pine and Douglas Fir, the third treatment was impregnated into Douglas Fir only. The test program was expanded, at the Bureau's request, to include two additional treatments. These were the impregnation of both of the above woods with one and five percent solutions of phenylmercuric oleate in creosote-coal tar solution.

MATERIALS

All piling materials were obtained and treated by the Koppers Company, Wood Preserving Division, Orrville, Ohio, with the exception of the ammoniacal copper arsenate treated piles which were treated at a West Coast plant. The piling were nominally 18 feet in length with butt and tip diameter normal for this size stock. Complete details of the piling procurement and treatment will be supplied by the Koppers Company, along with data on creosote retentions and mercury analysis.

ANALYSIS

Two sets of borings were taken for assay purposes. One set was sent

to Dr. R. H. Bescher and the other to NCEL. The borings were taken near the mid-point of the pile and the holes in the piles were plugged with "pencil-sharpened" plugs supplied by the Koppers Company, Wood Preserving Division, Orrville, Ohio. Borings from all piles of the same treating system were combined. As a result, each set had nine samples for analysis.

PREPARATION FOR INSTALLATION OF TEST PILES

On their arrival at Coco Solo the test piles had been stored in a hangar, Building 1148. There they were separated into the several treatment groups and bored, as shown in Figure 1. After the piles had been bored, they were moved to the pier near to which they would be driven, as shown in Figure 2. At a meeting in Washington, D. C. on 22 January 1963 (see Appendix A), it had been agreed that the piles would be driven in six groups of nine piles each. Each group would be driven in a block, as shown in Figure 3.

In order to remove bias from any possible effect of the position of a pile within the block pattern, six sets of random numbers from one to nine were obtained from a book of randum numbers. These position numbers are shown in Figure 4. The treatments are numbered one through nine in the order in which they appear in a list of treatments supplied to Rodman Naval Station Public Works Department, Figure 5. Each individual pile was also numbered. No attempt was made to randomize pile selection within a treatment. Instead, piles within a treatment group were driven in the order that they happened to be placed on the pier. The order in which each pile was positioned is given in Figure 6. The code letters identify the treatment and the kind of wood and the number identifies the individual pile within the group.

The piles were driven in the area between Seaplane Ramps 4 and 5 and along the pier adjacent to the hangar, Building 1138, shown in Figure 7. The water depth varied from 5 feet at the edge of the pier to 6 to 7 feet at a distance of 6 feet outboard from the pier. The first block of piles was driven off the mid-point of the pier and the other blocks were driven seaward from the first block.

Figure 8 shows a general view of the pile driving equipment with the segregated pile groups in the foreground. A pile is being hoisted up into the leads in Figure 9 and is being positioned just prior to driving in Figure 10. In Figures 11, 12, and 13 the pile is in the leads but is still being guided by one of the workers until it has penetrated at least 3 to 4 feet into the bottom. The completed operation is seen in Figure 14. The larger piles in the foreground are old piles that were part of a boat pier

Figure 1. Increment boring of piles

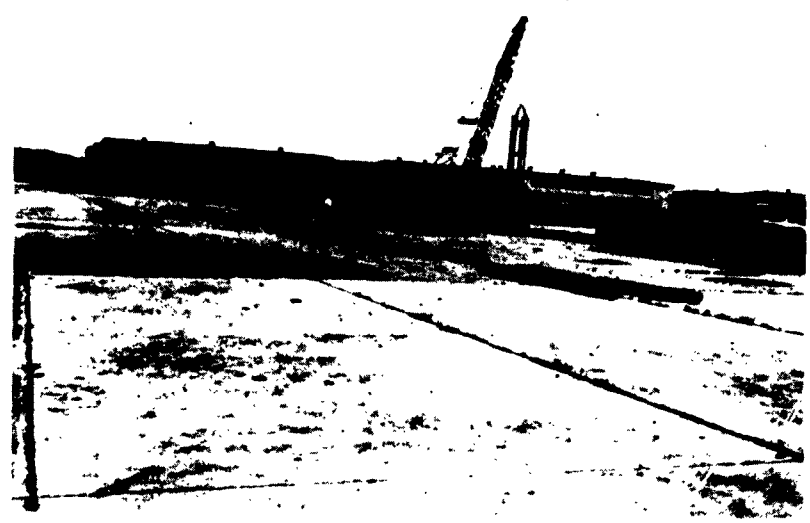

Figure 2. Grouping of piles on pier preparatory to driving

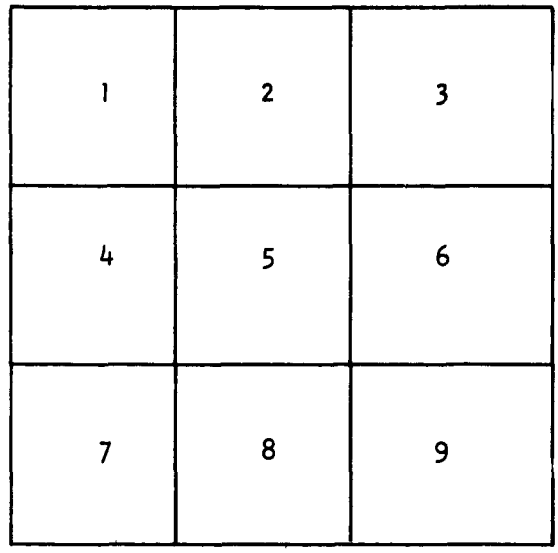

Figure 3. Block design and numbering system as viewed from the pier.

BLOCK NUMBER / POSITION NUMBER	1	2	3	4	5	6
1	7	3	7	7	7	4
2	2	6	5	2	6	6
3	3	9	6	5	1	9
4	5	4	1	4	4	7
5	8	7	8	1	8	5
6	6	5	3	9	9	2
7	1	8	4	6	5	3
8	4	2	9	8	2	1
9	9	1	2	3	3	8

Figure 4. Random numbers for each block.

ASSIGNED NUMBER	CODE	TREATMENT
1	CH-F	Ammoniacal copper arsenate followed by creosote in Douglas Fir
2	EC-F	Chromated copper arsenate followed by creosote in Douglas Fir
3	EC-P	Same as 2 in Southern Yellow Pine
4	T-F	70/30 creosote-coal tar solution in Douglas Fir
5	T-P	Same as 4 in Southern Yellow Pine
6	TP_1-F	70/30 creosote-coal tar solution containing 1% phenylmercuric oleate in Douglas Fir
7	TP_1-P	Same as 6 in Southern Yellow Pine
8	TP_5-F	70/30 creosote-coal tar solution containing 5% phenylmercuric oleate in Douglas Fir
9	TP_5-P	Same as 8 in Southern Yellow Pine

Figure 5. Numbering of Treatment Systems

TP_1-P-27	EC-F-21	EC-P-18
T-P-25	TP_5-F-31	TP_1-F-13
CH-F-7	T-F-28	TP_5-P-9

Block 1

EC-P-32	TP_1-F-11	TP_5-P-2
T-F-22	TP_1-P-33	T-P-2
TP_5-F-25	EC-F-12	CH-F-8

Block 2

TP_1-P-26	T-P-30	TP_1-F-3
CH-F-16	TP_5-F-34	EC-P-29
T-F-19	TP_5-P-12	EC-F-5

Block 3

TP_1-P-35	EC-F-9	T-P-20
T-F-16	CH-F-15	TP_5-P-8
TP_1-F-5	TP_5-F-33	EC-P-30

Block 4

TP_1-P-16	TP_1-F-2	CH-F-9
T-F-25	TP_5-F-27	TP_5-P-15
T-P-6	EC-F-18	EC-P-19

Block 5

T-F-17	TP_1-F-4	TP_5-P-13
TP_1-P-36	T-P-11	EC-F-23
EC-P-14	CH-F-15	TP_5-F-30

Block 6

Figure 6. Position of individual piles within blocks

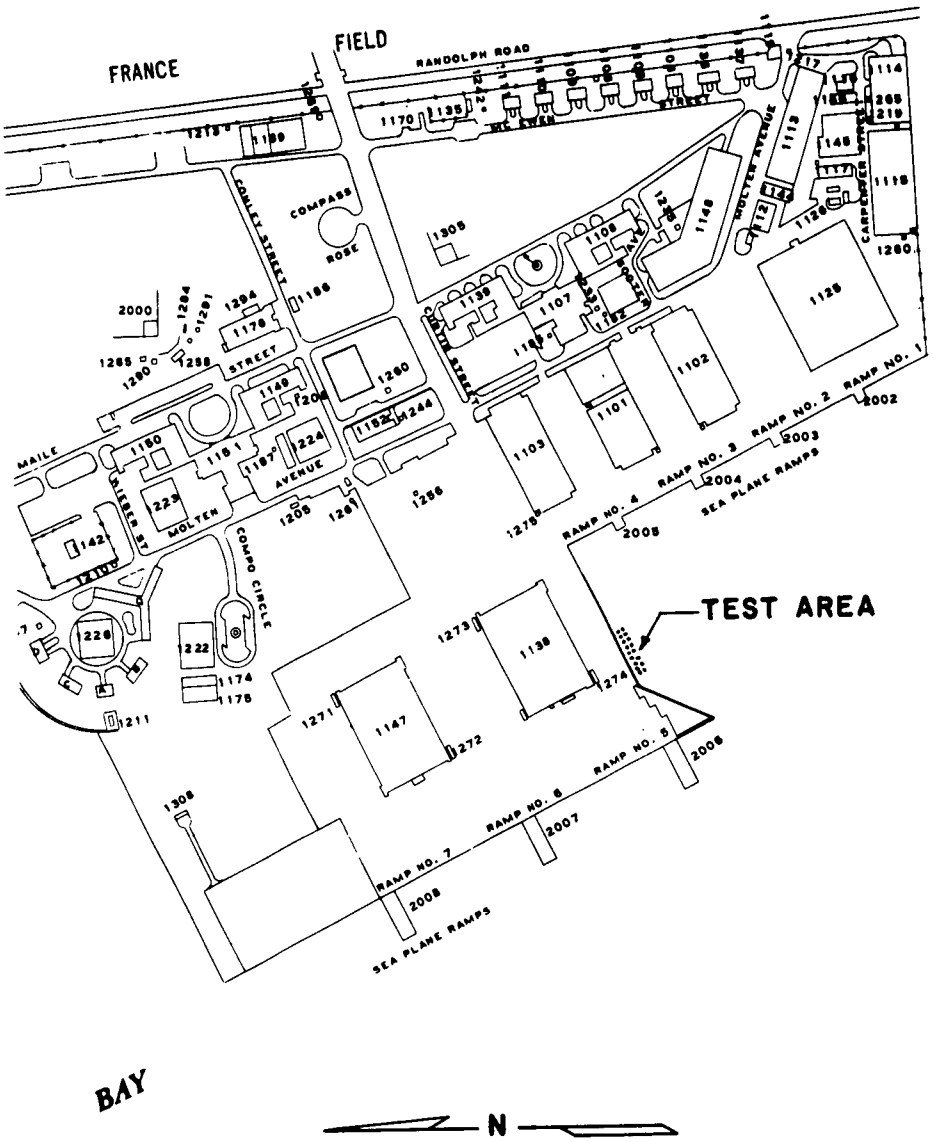

Figure 7. Map of Test Area

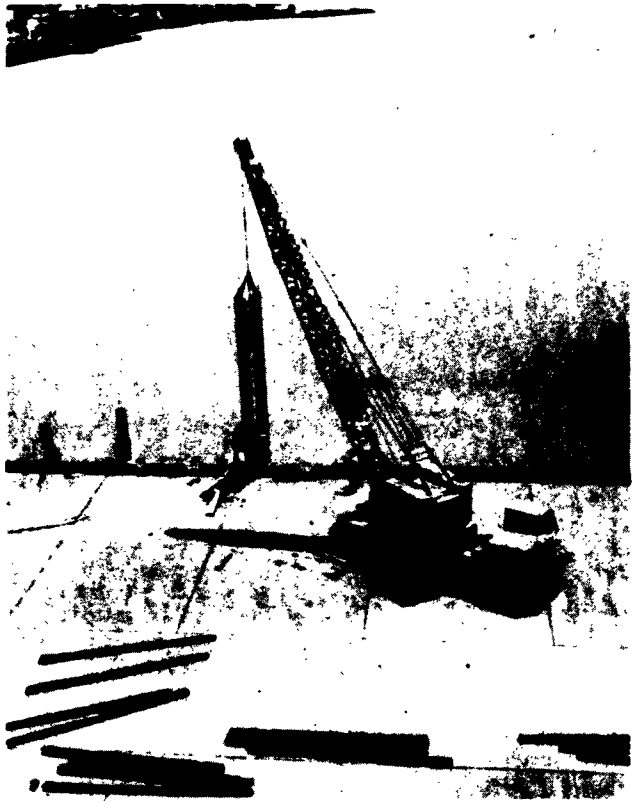

Figure 8. Pile driving equipment

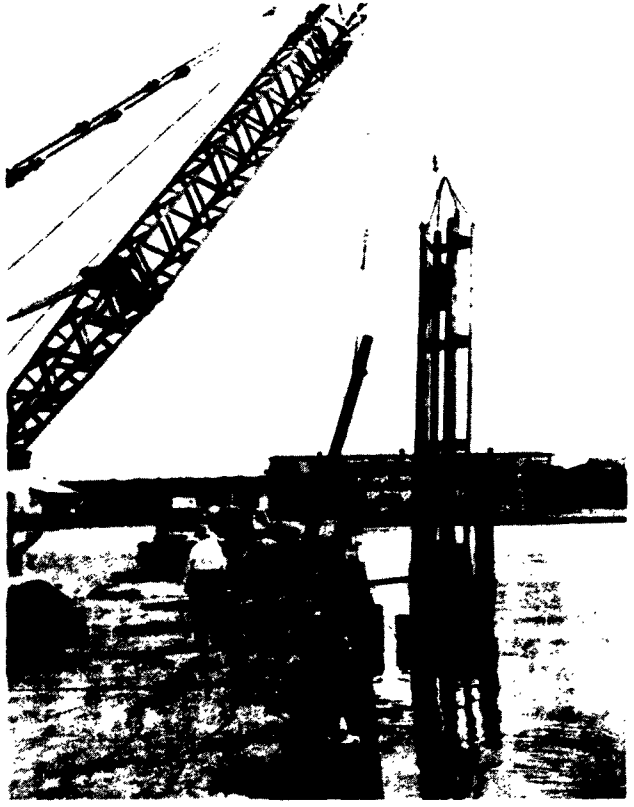

Figure 9. Pile being hoisted into leads

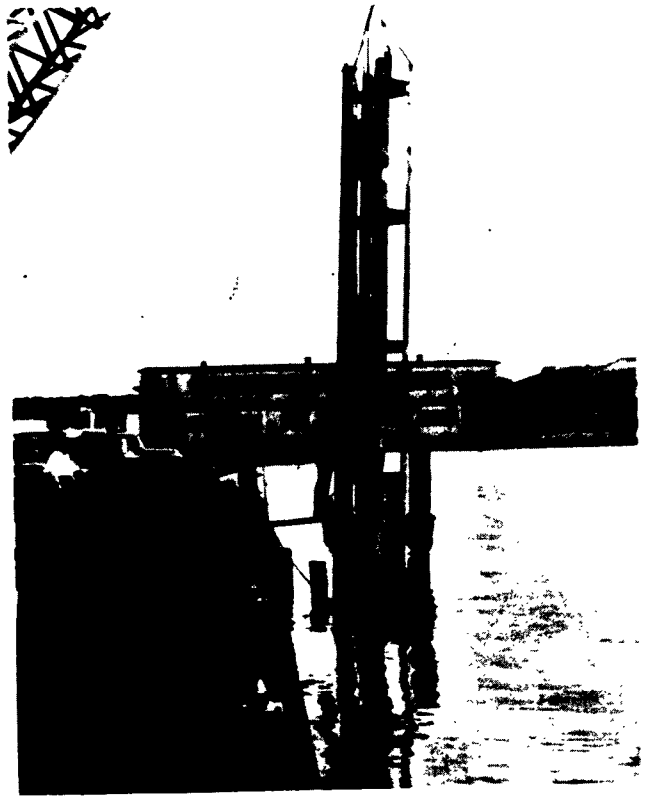

Figure 10. Pile positioned within leads

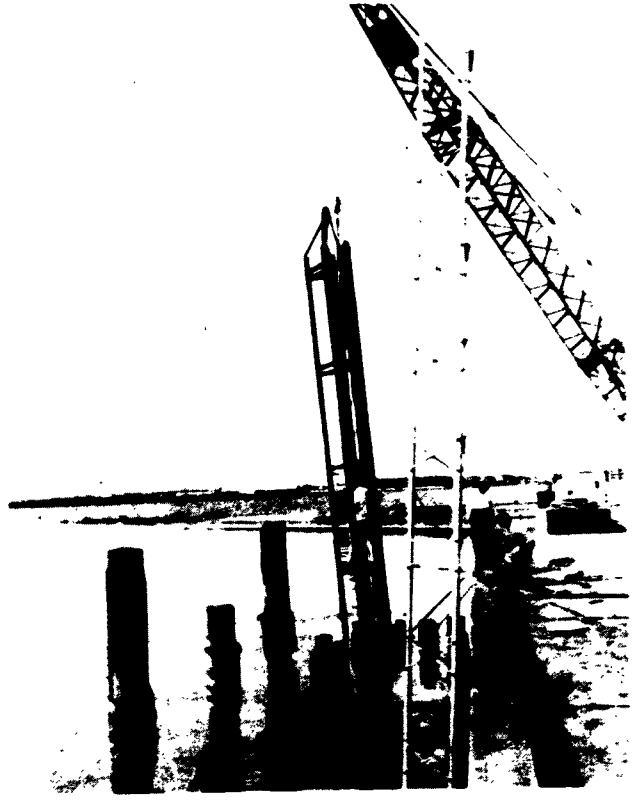

Figure 11. Start of driving

Figure 12. Manual positioning of pile

Figure 13. Manual positioning of pile driven a few feet into the bottom.

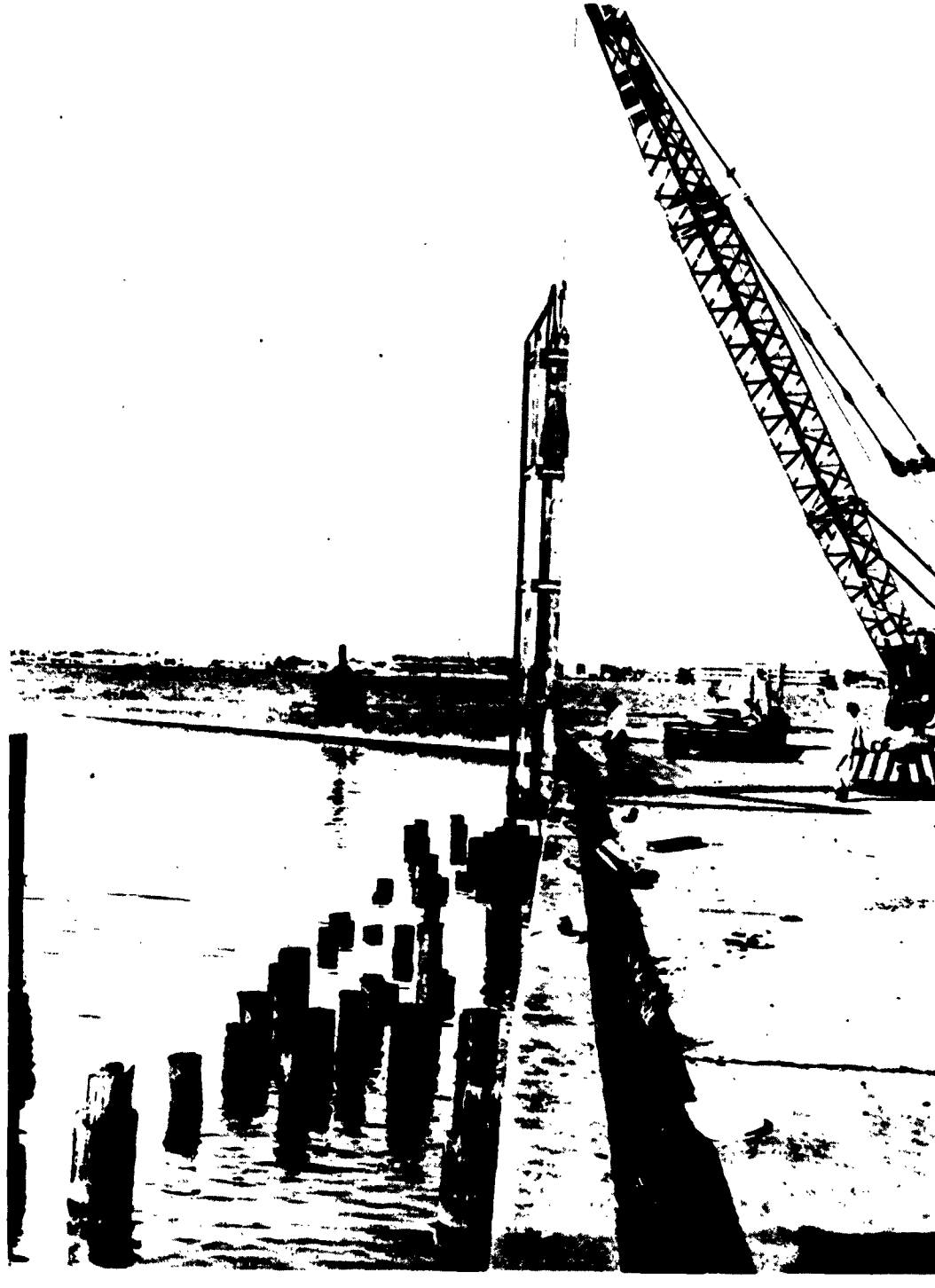

Figure 14. Appearance of area after pile driving was completed

built about 1954. These piles have been badly attacked by Limnoria and from one-third to one-helf of the cross section of these piles is gone in the mid-tide zone. The photograph was taken at high tide so the borer damage is not visible.

The piles were originally positioned so that they should have been driven in a square pattern of nine piles on 3 foot centers per square, and they should all have been driven to approximately the same depth. However, because of the type of coral sand and rock bottom, the piles did not drive true and some of them shifted as much as one to one and a half feet from the vertical in which they were originally set. As a result, the driving was quite uneven. At times when the pile hit a rock or a hard layer, several hard blows would be required to drive it through the layer, during which time the pile did not descend more than a few inches. As soon as the layer was penetrated, however, one blow of the hammer could easily send the pile down four to five feet. The relatively close spacing of the piles, both to each other and to the pier was dictated by the rapid slope of the harbor bottom.

OBSERVATIONS

The System 1 Piles -- the Douglas Fir piles treated with ammoniacal copper arsenate followed by creosote -- were all badly checked, as shown in Figures 15, 16, 17, and 18. The crack shown in Figure 17 went all the way through the pile. The pile probably cracked during the drying operation after the initial impregnation with the aqueous solution because the inside surfaces appeared to be well treated with creosote.

The ammoniacal copper arsenate treated piles were the cleanest appearing and the creosote-coal tar treated piles were dirty with considerable carry material on their surface.

Penetration of the preservatives into the Southern Yellow Pine was relatively uniform and deep, over 3 inches in all cases. Penetration into the Douglas Fir was quite variable and ranged from good to very poor. Practically all of the treatments of Douglas Fir with creosote-coal tar solutions were comparatively poor. Penetrations, in some cases, were less than 1/4 inch, and in no case was it observed to be over 1 inch.

ACKNOWLEDGEMENT

The administrative assistance by Mr. David L. Hartwell, Director Construction and Maintenance Division, District Public Works Office, and the technical assistance of Mr. Charles W. Hummer, Jr., Assistant Scientist in Charge, Naval Research Laboratory, Canal Zone Corrosion Laboratory, greatly expedited the pile installation. Mr. Hummer's photography helped appreciably in the writing of this report.

Figure 15. Appearance of Group I piles

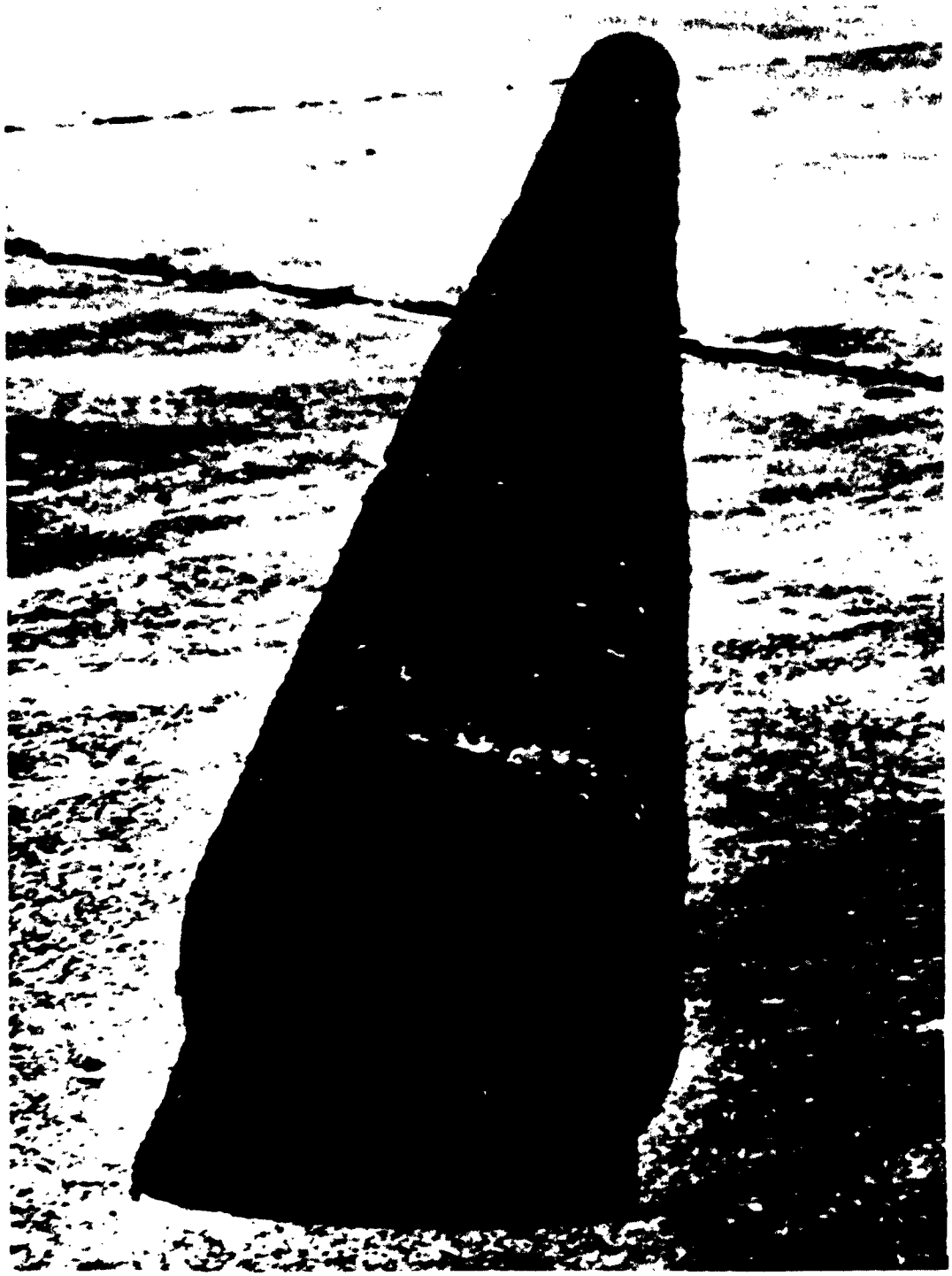

Figure 16. End view of Group I pile showing typical cracking pattern

Figure 17. Pen being inserted into crack

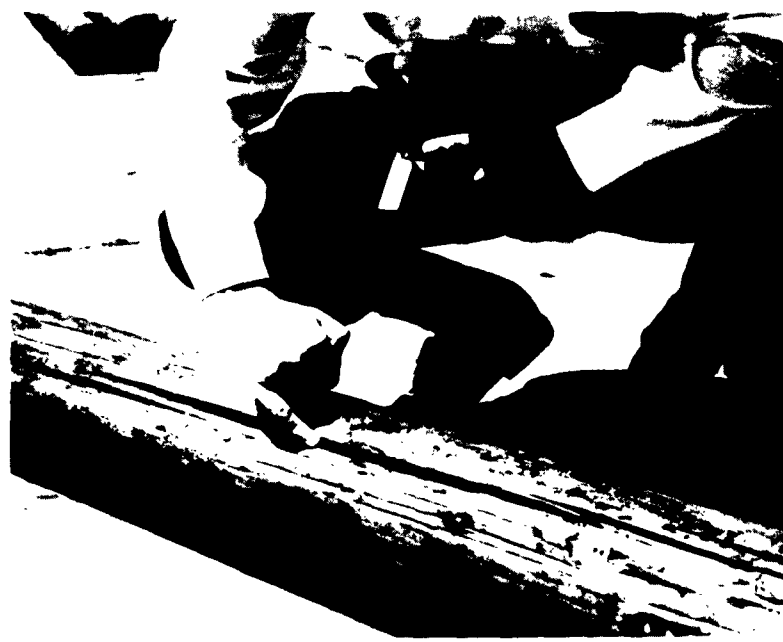

Figure 18. Crack more than 1/4 inch wide penetrating through the pile

APPENDIX A

22 January 1963

MEMORANDUM TO FILES

Subj: Cooperative Marine Piling Study; meeting on

1. On 22 January 1963 a meeting was held at the Dupont Plaza Hotel, Washington, D. C., for the purpose of obtaining the viewpoints of AWPI personnel relative to installing the subject piles at Coco Solo, Canal Zone. The following personnel were in attendance:

Mr. Ralph Bescher, Koppers Company and AWPI
Mr. R. Hawse, ASPI
Captain E. Gordon (Ret.), AWPI
Dr. H. Hochman, NCEL
Mr. T. Moller, BUDOCKS

2. The following agreement was reached:

a. Mr. Bescher will write the Bureau stating that the piles installed at Coco Solo contain the best treatments the industry has to offer at this time. In addition, he will state that the installation and procedure as noted in b. below is satisfactory to AWPI.

b. The Bureau stated the following:

(1) There are 54 piles (9 treatments, 6 per treatment), to be installed in blocks of 9 (3 rows, 3 in a row). Each row will be parallel to the shore line and spacing contingent on availability of space; but, if possible, approximating a pier.

(2) Two sets of borings from each pile are to be taken prior to installation. One set will be analyzed at NCEL. The other set is to be sent to Mr. R. Bescher. He is to arrange with Dr. R. Baechler, (USDA), to analyze these borings and provide the Bureau with a copy of the analysis. Possibly additional borings will be taken annually.

(3) The pilings are to be inspected, adequately tagged, and a plot plan made prior to installation. A report of findings, including the plot plan and photographs, where appropriate, is to be forwarded to the Bureau. A copy will be sent to Mr. R. Bescher who is representing AWPI.

(4) The inspection system, for the present, will be similar to that used by NCEL in their panel program (see TR-184). This was agreed to

by the above personnel. When the test has progressed to the point where damage is visible, the AWPI is to be advised. An inspection will then be arranged to include AWPI, NCEL, and other interested personnel.

/s/ T. H. Moller